CLAIMS

What is claimed is:

1. A method for forming an electrostatically-doped carbon nanotube device, comprising:

providing a carbon nanotube having a first end and a second end;

disposing a first metal contact directly adjacent to the first end of the carbon nanotube, wherein the first metal contact is electrically coupled to the first end of the carbon nanotube;

disposing a second metal contact directly adjacent to the second end of the carbon nanotube, wherein the second metal contact is electrically coupled to the second end of the carbon nanotube;

disposing a first metal electrode adjacent to and at a distance from the first end of the carbon nanotube, wherein the first metal electrode is capacitively coupled to the first end of the carbon nanotube;

disposing a second metal electrode adjacent to and at a distance from the second end of the carbon nanotube, wherein the second metal electrode is capacitively coupled to the second end of the carbon nanotube;

selectively applying a first bias to the first metal electrode to electrostatically dope the first end of the carbon nanotube; and

selectively applying a second bias to the second metal electrode to electrostatically dope the second end of the carbon nanotube.

2. The method of claim 1, wherein the carbon nanotube comprises a carbon nanotube selected from the group consisting of a single-walled carbon nanotube and a multi-walled carbon nanotube.

3. The method of claim 1, wherein the carbon nanotube acts as a semiconductor material.

4. The method of claim 1, wherein the carbon nanotube has a center section disposed between the first end and the second end.

5. The method of claim 4, further comprising disposing at least one of a semiconductor material and a metal layer adjacent to at least a portion of the center section of the carbon nanotube, wherein the at least one of the semiconductor material and the metal layer is operable for modulating the doping of the center section of the carbon nanotube.

6. The method of claim 5, wherein the at least one of the semiconductor material and the metal layer comprises a material selected from the group consisting of Si, SiC, Al, Cr, Mo, Ti and Pt.

7. The method of claim 5, further comprising disposing a dielectric material directly adjacent to a surface of the at least one of the semiconductor material and the metal layer, wherein the dielectric material is disposed between the at least one of the semiconductor material and the metal layer and the carbon nanotube.

8. The method of claim 7, wherein the dielectric material is disposed about the first metal electrode and the second metal electrode.

9. The method of claim 7, wherein the dielectric material comprises a dielectric material selected from the group consisting of SiO_2, Si_3N_4, Al_2O_3 and ZrO_2.

10. The method of claim 1, wherein the first metal contact and the second metal contact each comprise a metal selected from the group consisting of Ti, Mo, Au and Cr.

11. The method of claim 1, wherein the first metal electrode and the second metal electrode each comprise a metal selected from the group consisting of Mo, Ti, Pt and Au.

12. The method of claim 1, wherein the first metal electrode is separated from the second metal electrode by a distance of between about 100 nm and about 10 microns.

13. The method of claim 1, wherein the first metal electrode is separated from the first end of the carbon nanotube and the second metal electrode is separated from the second end of the carbon nanotube by a distance of between about 2 nm and about 100 nm.

14. The method of claim 1, wherein selectively applying the first bias to the first metal electrode to electrostatically dope the first end of the carbon nanotube comprises making the first end of the carbon nanotube one of a p-type semiconductor (hole majority carrier) and an n-type semiconductor (electron majority carrier).

15. The method of claim 1, wherein selectively applying the second bias to the second metal electrode to electrostatically dope the second end of the carbon nanotube comprises making the second end of the carbon nanotube one of a p-type semiconductor (hole majority carrier) and an n-type semiconductor (electron majority carrier).

16. The method of claim 5, wherein modulating the doping of the center section of the carbon nanotube comprises making the center section of the carbon nanotube one of a p-type semiconductor (hole majority carrier), an I-type (intrinsic) semiconductor and an n-type semiconductor (electron majority carrier).

17. The method of claim 1, wherein disposing the first metal contact directly adjacent to the first end of the carbon nanotube and disposing the second metal contact directly adjacent to the second end of the carbon nanotube comprise providing the first metal contact and the second metal contact prior to providing the carbon nanotube.

18. The method of claim 1, wherein disposing the first metal contact directly adjacent to the first end of the carbon nanotube and disposing the second metal contact directly adjacent to the second end of the carbon nanotube comprise providing the first metal contact and the second metal contact subsequent to providing the carbon nanotube.

19. A structure for forming an electrostatically-doped carbon nanotube device, comprising:

a carbon nanotube having a first end and a second end;

a first metal contact disposed directly adjacent to the first end of the carbon nanotube, wherein the first metal contact is electrically coupled to the first end of the carbon nanotube;

a second metal contact disposed directly adjacent to the second end of the carbon nanotube, wherein the second metal contact is electrically coupled to the second end of the carbon nanotube;

a first metal electrode disposed adjacent to and at a distance from the first end of the carbon nanotube, wherein the first metal electrode is capacitively coupled to the first end of the carbon nanotube;

a second metal electrode disposed adjacent to and at a distance from the second end of the carbon nanotube, wherein the second metal electrode is capacitively coupled to the second end of the carbon nanotube;

wherein the first metal electrode is operable for receiving a first bias to electrostatically dope the first end of the carbon nanotube; and

wherein the second metal electrode is operable for receiving a second bias to electrostatically dope the second end of the carbon nanotube.

20. The structure of claim 19, wherein the carbon nanotube comprises a carbon nanotube selected from the group consisting of a single-walled carbon nanotube and a multi-walled carbon nanotube.

21. The structure of claim 19, wherein the carbon nanotube acts as a semiconductor material.

22. The structure of claim 19, wherein the carbon nanotube has a center section disposed between the first end and the second end.

23. The structure of claim 22, further comprising at least one of a semiconductor material and a metal layer disposed adjacent to at least a portion of the center section of the carbon nanotube, wherein the at least one of the semiconductor material and the metal layer is operable for modulating the doping of the center section of the carbon nanotube.

24. The structure of claim 23, wherein the at least one of the semiconductor material and the metal layer comprises a material selected from the group consisting of Si, SiC, Al, Cr, Mo, Ti and Pt.

25. The structure of claim 23, further comprising a dielectric material disposed directly adjacent to a surface of the at least one of the semiconductor material and the

metal layer, wherein the dielectric material is disposed between the at least one of the semiconductor material and the metal layer and the carbon nanotube.

26. The structure of claim 25, wherein the dielectric material is disposed about the first metal electrode and the second metal electrode.

27. The structure of claim 25, wherein the dielectric material comprises a dielectric material selected from the group consisting of SiO_2, Si_3N_4, Al_2O_3 and ZrO_2.

28. The structure of claim 19, wherein the first metal contact and the second metal contact each comprise a metal selected from the group consisting of Ti, Mo, Au and Cr.

29. The structure of claim 19, wherein the first metal electrode and the second metal electrode each comprise a metal selected from the group consisting of Mo, Ti, Pt and Au.

30. The structure of claim 19, wherein the first metal electrode is separated from the second metal electrode by a distance of between about 100 nm and about 10 microns.

31. The structure of claim 19, wherein the first metal electrode is separated from the first end of the carbon nanotube and the second metal electrode is separated from the second end of the carbon nanotube by a distance of between about 2 nm and about 100 nm.

32. The structure of claim 19, wherein the first bias is operable for making the first end of the carbon nanotube one of a p-type semiconductor (hole majority carrier) and an n-type semiconductor (electron majority carrier).

33. The structure of claim 19, wherein the second bias is operable for making the second end of the carbon nanotube one of a p-type semiconductor (hole majority carrier) and an n-type semiconductor (electron majority carrier).

34. The structure of claim 23, wherein the semiconductor material is operable for making the center section of the carbon nanotube one of a p-type semiconductor (hole majority carrier), an I-type (intrinsic) semiconductor and an n-type semiconductor (electron majority carrier).

35. A method for forming an electrostatically-doped carbon nanotube device, comprising:

providing at least one of a semiconductor layer and a metal layer having a surface;

disposing a first insulating layer having a surface on the surface of the at least one of the semiconductor layer and the metal layer;

patterning and selectively disposing a metal electrode material having a surface on the surface of the first insulating layer;

disposing a second insulating layer having a surface on the surface of the first insulating layer and the surface of the metal electrode material;

patterning and selectively disposing a metal contact material having a surface on the surface of the second insulating layer;

patterning and selectively disposing a catalyst material on the surface of the metal contact material; and

growing a carbon nanotube from the catalyst material, wherein the carbon nanotube is aligned substantially parallel to the surface of the second insulating layer, and wherein a portion of the carbon nanotube is in contact with a portion of the metal contact material.

36. The method of claim 35, wherein patterning and selectively disposing the metal electrode material on the surface of the first insulating layer comprises selectively disposing a first area of metal electrode material and a second area of metal electrode material on the surface of the first insulating layer.

37. The method of claim 36, wherein patterning and selectively disposing the metal contact material on the surface of the second insulating layer comprises selectively disposing a first area of metal contact material and a second area of metal contact material on the surface of the second insulating layer, the first area of metal contact material disposed adjacent to the first area of metal electrode material and the second area of metal contact material disposed adjacent to the second area of metal electrode material.

38. The method of claim 37, wherein the carbon nanotube has a first end that is in contact with the first area of metal contact material and a second end that is in contact with the second area of metal contact material.

39. The method of claim 35, wherein the at least one of the semiconductor layer and the metal layer comprises a material selected from the group consisting of Si, SiC, Al, Cr, Mo, Ti and Pt.

40. The method of claim 35, wherein the at least one of the semiconductor layer and the metal layer has a thickness of between about 1 micron and about 550 microns.

41. The method of claim 35, wherein the first insulating layer and the second insulating layer each comprise a dielectric material selected from the group consisting of SiO_2, Si_3N_4, Al_2O_3 and ZrO_2.

42. The method of claim 35, wherein the first insulating layer has a thickness of between about 2 nm and about 100 nm.

43. The method of claim 35, wherein the second insulating layer has a thickness of between about 2 nm and about 100 nm.

44. The method of claim 35, wherein the metal electrode material comprises a metal selected from the group consisting of Mo, Ti, Pt and Au.

45. The method of claim 35, wherein the metal electrode material has a thickness of between about 10 nm and about 100 nm.

46. The method of claim 35, wherein the metal contact material comprises a metal selected from the group consisting of Ti, Mo, Au and Cr.

47. The method of claim 35, wherein the metal contact material has a thickness of between about 10 nm and about 100 nm.

48. The method of claim 37, wherein patterning and selectively disposing the catalyst material on the surface of the metal contact material comprises selectively disposing the catalyst material on one of the first area of metal contact material and the second area of metal contact material.

49. The method of claim 35, wherein the catalyst material comprises a catalyst material selected from the group consisting of a thin film and a nanoparticle.

50. The method of claim 35, wherein the catalyst material comprises a catalyst material selected from the group consisting of Ni, Fe, Co, Mo and Al_2O_3 in Fe nitrate.

51. The method of claim 35, wherein growing the carbon nanotube from the catalyst material comprises growing a carbon nanotube selected from the group consisting of a single-walled carbon nanotube and a multi-walled carbon nanotube.

52. The method of claim 35, wherein the carbon nanotube acts as a semiconductor material.